APPENDIX A

Final Panel Comments

on the

Integrated Feasibility Study and Environmental Impact Statement for the Louisiana Coastal Area (LCA) – Terrebonne Basin Barrier Shoreline Restoration Terrebonne Parish, Louisiana

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Comment 1:

The evaluation of structural measures (i.e., offshore breakwaters and terminal groins) needs to include additional information and analysis to support their inclusion in the National Ecosystem Restoration (NER) plan, while revetments are excluded.

Basis for Comment:

The ability to evaluate the project alternatives is limited by incomplete description and analyses regarding (1) the potential effect of breakwaters or terminal groins on the long-term performance of the improved islands and/or the adjacent shores, and (2) performance of rock revetments. Neither Section 3 of the Terrebonne main report nor the engineering appendix provides adequate justification for the use of offshore breakwaters and/or terminal groins as recommended in the NER plan. Furthermore, no data are presented to justify the exclusion of rock revetments.

- The Terrebonne report does not present a description, relevant details of the modeling results, or prototype data from existing structures to explain the anticipated effects of structures upon the individual islands or the barrier island system as a whole. For example, the report does not discuss the adverse impacts that structures might cause to other adjacent (downdrift) shorelines, due to the disruption of sediment transport, or the anticipated degree and manner of storm and washover effects on the long-term performance of the structures.

- The STWAVE/GENESIS evaluation of island response, particularly to structures, is not sufficient to justify the use of breakwaters or terminal groins in the NER plan. For example, in applying the GENESIS model, a very large cross-shore transport signal (background retreat rate) had to be introduced to the model, amounting to between seven and nine meters of retreat per year. It would appear that the result of this artificial signal influenced the outcome of the model predictions more than the alongshore transport signals developed by the model. Moreover, in modeling the breakwaters offshore of Whiskey Island, the cross-shore transport signal was manually reduced by 50% (Section 1.8.1, Annex L-3); but then the report concludes, in Table 1-3 of Annex L-3, that the shoreline change rate at Whiskey Island decreased from -13.8 meters/year without structures to -8.2 meters/year with structures. However, it is questionable whether most of this 40% reduction in shoreline retreat was associated with the artificially imposed 50% reduction in cross-shore transport (not the structures). Also, sand was "inserted" into the model to demonstrate the benefit of detached breakwaters. Justification for this addition was based upon qualitative observations at Raccoon Island which suggested that sand probably moved onshore from shoals beyond the "closure depth" (Annex L3, p. 15 and Figures 1-6, 7). As such, the manner in which the model was applied appears to have forced the model's results, and these results were then used to justify inclusion of breakwater and terminal groin structures.

- In contrast to the inclusion of breakwaters, revetments are eliminated without sufficient justification. Failure of revetments to meet project objectives is alluded

to in Lines #2371-3 and Lines #2388-93 of the Terrebonne report; but the reasons for this failure and/or specific performance of revetments are not clearly delineated in a manner that justifies elimination of this measure. Figures 2-26 through 2-28, for example, present photographs suggesting that the revetments on Timbalier and East Timbalier Islands may perform adequately. Revetments may result in less intertidal (beach) habitat along the shoreline upon which they are constructed, but their use may increase the longevity or size of habitat in their lee, thus creating a greater net output in the average annual habitat acre (AAHA) value, particularly relative to the cost of dredged sand. Given that limited use of rock revetments would appear to be an otherwise obvious, potentially less expensive and longer-lasting solution than dredge fill, this alternative is not adequately evaluated beyond the existing Wine Island project segment.

- In Section 3.2.3 (more specifically, in 3.2.3.1.1), terminal groins are never discussed. Table 3-1 (p. 3-17) lists groins, including terminal groins, as a measure that is removed from further consideration. Terminal groins are, however, retained in the analysis and are even included as an element of one project in the Final Alternatives Array.

Significance – High:

Insufficient descriptions and analyses of (1) the potential effect of breakwaters or terminal groins on the long-term performance of the improved islands and/or the adjacent shores, and (2) performance of rock revetments could impact the selection or justification of the NER plan.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. A detailed description, including data, of the performance of existing breakwater structures at the project area.
2. Alternative modeling of breakwater and revetment structures that addresses the structures' anticipated effect to adjacent islands and response to storm events.
3. Prototype data, a detailed description, and/or at least screening-level analysis that justifies exclusion of revetments as a project approach beyond Wine Island.
4. Revision of Section 3.2.3 by which terminal groins (not excluded from the alternatives) are distinguished from other groins (that are excluded from the alternatives).

Comment 2:

Physical processes should be analyzed for the Terrebonne Basin barrier island system as a whole.

Basis for Comment:

The analysis of physical processes was limited to individual islands. However, analysis of physical processes of the barrier island system as a whole is necessary to formulate a preferred project that enhances the barrier island system. Also, the effects of the proposed projects cannot be assessed without considering island system processes, such as sediment transport between islands and the surrounding sea bed. Understanding these aspects of sand transport is particularly important for the proposed structural measures (terminal groin and detached breakwaters), which are designed to reduce sand transport, because it is possible that these structural measures may be counter-productive.

The description of system morphologic processes clearly links the islands in a system connected by sediment supply, subsidence, sand transport, and other physical processes at the regional level.. However, the Terrebonne project addressed simplified objectives of restoring individual island functions in terms of beach, dune, and marsh morphologies. The plan formulation therefore was simplified to consider the area of island created within certain elevation ranges. While practical, the viability of island area as a surrogate for barrier island system functions is not well established, and this is acknowledged.

The sand transport analysis focused on individual islands and was limited to a one-line, equilibrium profile model (GENESIS) and a profile-based storm response model (SBEACH). These models only account for a portion of the sand transport process. The Terrebonne report qualitatively discusses sand transport between islands, and one reason provided for island degradation is blockage of sediment supply; however, this transport is not modeled or otherwise analyzed. The effects of sea level rise (SLR), subsidence, and changes in the rates of these processes also were not addressed.

Inclusion of detached breakwaters and a terminal groin also has implications for island vs. system analysis. The effects of these structures were considered only in terms of local erosion prevention, not in terms of interfering with sediment transport between islands and with the sea bed. Because the analysis did not address the potential adverse effects of structures, especially between adjacent islands, the inclusion of structures seems arbitrary.

Significance – High:

Consideration of island-system physical processes is necessary to assess the ecosystem benefits and effects from the TSP and other alternatives to justify the selected plans and to avoid unintended adverse effects.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include a quantified description and analysis of physical processes affecting the morphology of the Terrebonne barrier island system, which provides benefits to the wetlands and estuary in the lee of the island chain. Specifically, the analysis should quantitatively describe the following processes for the barrier island system as a whole.

1. Island migration (vs. shoreline erosion) and system-wide sediment processes; the analysis should include:
   - Re-evaluation of sand transport along the sea bed below the estimated closure depth.
   - Combined wave and current modeling of sand transport along the island system, including episodic events such as surges due to frontal passage.
   - Geomorphic analysis of sand movement at inlets in normal and episodic forcing.
   - Island migration and evolution patterns, including marsh migration and sand/sediment trapping.
   - Effects and effectiveness of detached breakwaters, terminal groins, and any other structural measures that are included in alternatives.
   - Borrow pit effects on sediment transport.
   - Effects of accelerated SLR on the recession of the island shorelines and migration rates.
2. Land subsidence causes and whether future subsidence rates will be the same as historic rates or if they will increase or decrease.
3. Time scales of tidal wetland evolution vs. island migration.
4. Sediment budgets.

Comment 3:

More information from critically important studies regarding physical processes (including modeling, analysis, and prior project performance) needs to be provided in the Terrebonne report.

Basis for Comment:

Information that is central to understanding the physical causes and nature of the problem to be solved, and the potential for success and/or unanticipated adverse impacts of the proposed NER and TSP project solutions, is not sufficiently described in the report. Critically important studies are mentioned, but no information to support the project is provided. Some of these key studies include:

- Borrow pit impact modeling (waves)
- Historical aerial photograph analysis
- Island migration analysis
- Subsidence, and relationship to oil and gas extraction

There is no description of the modeling effort, results, or prior project observations that relate to the effect of the offshore dredging upon the adjacent/leeward barrier islands. There is mention, but no inclusion, of historic aerial photographs that would otherwise illustrate the severity and physical mode of the islands' erosion, migration, and transconfiguration over the past few decades. There is also no discussion of the extent to which the islands themselves have subsided and the degree to which this might be related to mineral extraction. The description of the historical and existing sedimentation and erosion conditions in the study area is insufficient to understand causes of the islands' deterioration and the rate at which they are disappearing through alongshore migration, rollover, diffusion, subsidence, or more classical shoreface erosion.

The performance to date of only some of the previously constructed projects is described. However, the details and performance of projects that relate to the subject of the TSP (such as TE-50 at Whiskey Island (lines #400-407)) are not described. It is not always clear what, if any, portions of the described projects have been actually built (e.g., TE-40, lines 370-376) vs. their stated objectives. For example, Section 1.5.1.5 (line #400) suggests that the TE-50 marsh project has been built on Whiskey Island, but its presence is not evident in the 2008 aerial photograph in Figure 2.9 (p. 2-6), and the report does not indicate whether the marsh project was built after the 2008 photograph. For those projects that have been built, it is difficult to understand what they look like and whether they have completely or partially met the performance expectations.

The report does not describe those aspects of prior barrier island restoration projects that have been unsuccessful or which have exhibited substandard performance. Without this description, it is not clear (1) how the problems of unsuccessful projects have been addressed in the proposed plan, (2) what performance objectives of the proposed plan may be least certain or most difficult to achieve, and (3) which may be of particular importance to monitor.

Significance – High:
The ability to evaluate the potential physical effectiveness of the proposed TSP and/or NER plan is greatly limited by the absence of reliable, calibrated modeling of shoreline response to littoral transport, storms, dredging, and structures from previous projects and studies, and by the absence of a description of the historically observed changes to the islands from (1) prevailing natural processes and (2) prior project construction and performance.
Recommendation(s) for Resolution:
To resolve these concerns, the report would need to be expanded to include: 1. A discussion of the predicted effects of offshore dredging upon the islands based on previous studies. 2. A summary of the islands' historical migration/erosion patterns through representative (historical) aerial photographs and/or graphic overlays of historical island shorelines. 3. A description of the apparent, dominant modes of historical island erosion. 4. An expanded description of the extent to which specific prior projects (mentioned in the report) have already been constructed, and the degree to which these projects met objectives and/or anticipated performance. 5. The manner by which the proposed plan may result in improved project performance relative to prior, similar projects.

Comment 4:

The initial short-term impacts to habitat due to project construction need to be quantified in more detail, and revisions to designs and construction should be considered to reduce potential impacts.

Basis for Comment:

The conceptual restoration plans in Appendix B indicate that much of the existing islands will be buried with dredged material. This loss of existing habitat and the delay in new habitat establishment are not quantified or included in the calculation of ecologic benefits. Minimizing construction impacts is not discussed as a design objective.

According to the letter from the U.S. Fish and Wildlife Service (USFWS) in Appendix A, it is likely that the project would seriously reduce food availability for piping plovers by killing most of the benthic invertebrates on the islands where construction is proposed. The USFWS also requested consideration of sea turtle nesting periods to avoid disrupting or disturbing nesting activities. However, the description of the project design and construction does not address how to minimize impacts to these sensitive populations.

Although the Terrebonne report states that imperiled vegetative communities inhabit the islands, it is suggested that the only adverse effects to vegetative communities will be due to the smothering of vegetation scattered about the islands. These statements are not in agreement and are difficult to reconcile. The report also states that ecological function requires vegetated dunes and back barrier marsh, yet it appears that existing vegetation is not avoided in the designs, especially the higher-volume designs (e.g., designs D and E). Vegetation planting is included in the designs, but it is difficult to ascertain how effective the revegetation will be, and at what point in time created habitat will be sufficient to mitigate the construction effects. The benefits of the project as currently designed may be negative in the first few years (possibly up to a decade) after construction, due to the loss of existing habitat.

The Terrebonne report repeatedly says that Alternative 5 (NER plan) would have similar effects as Alternative 11 (TSP), except that the NER plan is larger, and thus, the effects would be greater. This implies that the any initial loss of habitat may also be scaled up with the NER.

The Terrebonne report (p. 3-48) indicates that the Wetland Value Assessment (WVA) method does not account for the differences in vegetation and habitat before and after construction, implying that project benefits are based solely on net acres of area created within defined elevation ranges. The conditions (whether vegetated or existing habitat) are not considered explicitly. For example, Table 3-7 indicates existing habitat to be 377 acres of dune habitat and 443 of intertidal habitat (Alternative 1), and that the Whiskey Island Plan C will result in 895 acres and 377 acres of dune and intertidal habitat, respectively. This suggests a net loss of about 14% wetland in Year 1. Table 3-22, Summary of Habitat Value for Alternative 5, indicates that intertidal habitat lost in Year 1 would amount to about 268 acres (1316-1048), which is approximately 20% loss. However, the loss of existing intertidal habitat (wetland) is probably much greater since

much of the net Year 1 intertidal area will be "restored" areas, and the engineering plans show burial of existing intertidal areas. The loss of existing dune and beach habitat due to construction is not defined.

The Engineering Appendix L, Section L6.6.5, states that the Whiskey and Raccoon Island designs were modified to avoid damaging restoration areas constructed previously. Therefore, the designs of Raccoon and Whiskey Islands will likely have fewer adverse construction impacts. However, the more extensive plans (D and E) appear to cover existing habitat (e.g., line 7 for Raccoon Island Plan E). Also, it is not clear whether and to what extent existing habitat will be considered in plans for other islands and as design continues (Timbalier Island is almost completely buried in Plan E).

Significance – High:

Failure to consider initial short-term impacts from project constructions could lead to designs that are more destructive to existing habitat than necessary and have lower success because recovery time will be extended.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include quantification and consideration of construction impacts to existing habitat and net habitat over time and space, including the following:

1. Describe and quantify habitat losses due to construction associated with the conceptual grading plans for the TSP and NER plan.
2. Include the anticipated evolution toward reestablishment of habitat, and calculate the net ecological benefits over time.
3. Refine the conceptual designs and design criteria to reduce construction impacts to existing habitat.
4. Revise fill placement limits/geometry to obtain the same net increase in habitat area but reduce loss of existing habitat.
5. In consultation with biologists/ecologists, use phased fill placement for reduced short-term impacts and more rapid recovery of impacted areas.
6. Use low-impact methods of fill placement, if identified.
7. Develop design criteria to be considered in subsequent design refinements.
8. Develop species protection criteria for sensitive and listed species.

Comment 5:

The accuracy of the predicted effects of storm events and sediment transport is uncertain.

Basis for Comment:

The accuracy of the predicted effects of storm events and sediment transport is uncertain for several reasons.

- Hydrodynamic storm modeling was limited to wave hindcast data transferred using STWAVE. The sand transport modeling was limited to a one-line, equilibrium profile model (GENESIS) and a profile-based storm response model (SBEACH). The above models each cover a portion of the hydrodynamic and sediment transport processes affecting the islands. While often used, their utility to this study is limited, and other models and analyses could have been applied.
- The GENESIS model does not address the processes which govern most of the shoreline change, as acknowledged in the Engineering Report (Appendix L and Annex L3). The GENESIS modeling did not address key processes such as onshore transport, inlets, island migration, and transport between islands.
- Calibration data are not given for the SBEACH model results; therefore, it is not possible to determine how reasonable the results might be. Furthermore, the input values used for SBEACH are not given, and the basis for the outcome of the analysis is not apparent.
- No data are presented to substantiate the depth of closure, which at only about 10 feet (ft) appears to be very shallow given the episodic occurrence of 30+-ft storm wave heights that are probably responsible for the majority of nearshore sediment transport. It appears that the closure depth for the Terrebonne Islands was recalculated using smaller wave heights (justified by wave dissipation) to better conform with the broad, relatively shallow nearshore depths in the vicinity of the study area. However, the closure depth may not indicate the depth limit of significant sand transport, as apparently assumed in the analysis. This assumption is not substantiated and may, in fact, be incorrect since it is also observed that sand moved onshore from offshore shoals at Raccoon Island.
- Sand was "inserted" into the sediment transport model to demonstrate the benefit of detached breakwaters. This was justified by observations at Raccoon Island that sand probably moved onshore from shoals beyond the "closure depth" (Annex L3, p. 15 and Figures 1-6, 7).
- The benefit of breakwaters was imposed as a 50% reduction in the residual retreat rate from the original long-term cross-shore related shoreline change rate (Section 1.8-1 of Annex L3).
- The modeling does not represent the effects of SLR on increasing shoreline recession and island migration. Modeling these processes may be challenging, and applied geomorphology may provide better tools. Such methods include simplified geometric approximations such as the "Bruun Rule."

The scope of analysis was probably constrained, perhaps due to complexity of the natural process. However, more effort could improve the NER plan and serve as a basis for technical development for future island restoration projects, within the context of a programmatic monitoring and adaptive management process.

Significance – Medium:

The success of the selected alternative may not be well understood because the analysis approach may not accurately predict the effects of storm events and sediment transport on project alternatives.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. Scientific justification for the assumptions and models used to predict storm events and sediment transport.
2. Use of a combined hydrodynamic circulation model and wave model with sediment transport to predict the likely sand transport patterns and rates with and without project, and to inform NER plan and Adaptive Management and Monitoring Plan refinements.
3. Calibration, validation, or verification data for the SBEACH profile response to storms using available data. In the absence of pre- and post-storm data along the Terrebonne Islands, profiles could be estimated for a given storm using aerial photographs and or survey data.
4. Quantification of island migration (vs. shore erosion) and system-wide sediment processes, including inlet bypassing and onshore sand transport. This should include:
    - Re-evaluation of sand transport along the sea bed below the estimated closure depth, including the influence of high storm waves upon the calculated depth of closure based on previous studies.
    - Combined wave and current modeling of sand transport along the island system, including episodic events such as surges due to frontal passage.
    - Geomorphic analysis of sand movement at inlets in normal and episodic forcing.
    - Island migration and evolution patterns, including sediment trapping, marsh migration, and sand trapping.
    - Effects and effectiveness of detached breakwaters, terminal groins, and any other structural measures included in alternatives.
    - Borrow pit effects on sediment transport.
5. Quantified effects of relative sea level rise (RSLR) using applied geomorphology, profile evolution modeling, and/or other modeling and sediment budget methods.
6. Complete sediment budgets for project conditions and predictions for the fate of sand transport.
7. A refined NER plan and Adaptive Management and Monitoring Plan based on the results of improved sand transport analysis.

8. Recommendations for future research and development that could develop technical tools to improve future island restoration projects.

Comment 6:

The economic criteria and approach used for overall project justification and plan formulation need to be clarified.

Basis for Comment:

The economic justification of the recommended project(s) is not clear because:

- The economic criteria for determining whether or not a project is economically justifiable are not explicitly stated and discussed.
- Although the plan formulation criteria are stated, in some cases they are ambiguously defined.
- Particular aspects of the economic approach are not adequately documented and defended.

The specific economic decision-making criteria used by the U.S. Army Corps of Engineers (USACE) to judge whether the projects are economically justified were not explicitly stated and defended in the Terrebonne main report or Appendix K. In particular, the choice of cost-effectiveness/incremental cost analysis (CE/ICA) over other economic decision-making criteria, such as benefit-cost analysis (BCA), was not explicitly discussed and defended. In addition, on p. 2-1 of the main report, it is stated that USACE considered both National Economic Development (NED) and NER objectives; however, it is not clear exactly how NED objectives were considered. Overall plan formulation criteria (not just economic criteria for deciding if a project is economically feasible) included "completeness, effectiveness, efficiency and acceptability" (as specified in ER 1105-2-100). The planning methods adequately met these criteria in terms of breadth of coverage (e.g., each of the criteria was addressed in the planning process). However, the definition of "efficiency" (p. 3-1, Terrebonne main report) is limited to relative cost-effectiveness, rather than the technical meaning of "economic efficiency" or "Pareto Efficiency" from an NED perspective. In general, achieving efficiency from an economic standpoint means that Pareto Efficiency (economic efficiency) has been achieved, or the project at least moves in the direction of Pareto Efficiency. Since a relatively cost-effective project, as defined in the Terrebonne main report, could be one for which the economic benefits are less than the economic costs, implementation of a relatively cost-effective project could actually move the nation (society) further away from Pareto Efficiency (economic efficiency).

Economic decision-making approaches with the purpose of identifying and selecting economically preferred projects typically consider all relevant constraints from the beginning of the selection process, including budget constraints. It is not clear why USACE did not incorporate the Congressionally determined project budget constraint until near the end of the preferred project selection process. Incorporation of this budget constraint earlier in the plan formulation process would have greatly shortened and focused this planning process. The concept of "Best Buy" is not well defined and defended, including if and why it should be considered as "the best investment" and whether it leads to maximization of benefits in all plan formulation criteria for the least

amount of cost. The description of the ICA on the bottom of p. 3-1 and the top of p. 3-2 (main report) is incomplete. For example, it is not clear why Table K3-1 on p. 3-2 only includes Alternative 1, 2, and 5. The discussion of the WVA model results is also incomplete (e.g., Table 3-30 and related narrative does not include all 10 alternatives, leading to ambiguity in project selection). It is not clear, for example, why Alternative 6, 7, and 8 are not accepted as final Institute for Water Resources (IWR) "Best Buy" alternatives even though their cost per average annual habitat unit (AAHU) is similar to Alternative 9, which is among the final IWR ("Best Buy") alternatives. Other technical concerns with the economic approach include incomplete consideration of cost uncertainty; nonlinearity in project benefits and costs; hard revetments; and potential cost savings from using Whiskey Island Back Barrier (TE-50) Borrow Area 1, relative to the assumed Borrow Area 3a.

Significance - Medium

Providing more detail on the economic criteria and approach will enable better, more complete understanding of the plan formulation process, economic analysis, and economic justification of the proposed project(s).

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. Explanation and justification for the choice of CE/ICA as the economic decision-making criteria for judging whether a project is economically justifiable as compared to more traditional economic choice criteria such as BCA.
2. Discussion of how NED objectives were considered.
3. Justification for the definition of "efficiency" used in the report as compared to the more technically correct definition from Pareto Efficiency and NED perspectives.
4. Explanation regarding why the Congressionally determined project budget constraint was considered at the end of the preferred project selection process, rather than at the beginning of this process.
5. Justification for the "Best Buy" criterion, including professional publication references.
6. More detailed discussion of the ICA, including explanation of why Table K3-1 (p. 3-2) only includes Alternative 1, 2, and 5.
7. Consideration of all 10 alternatives in Table 3-30 (as done in Table K2-1, Appendix K) and the related narrative, and more discussion of why Alternative 6, 7, and 8 were not included as "Best Buy" alternatives.
8. Consideration of potential cost savings from using Borrow Area 1 instead of Borrow Area 3a, recognizing the fact that BA1 is about half the distance from the project site as compared to BA3a.
9. More discussion of why cost uncertainty, nonlinearity of project benefits and costs, and hard revetments did not receive more attention during the preferred project selection process.

Comment 7:

Some of the assumptions used in the evaluation of alternatives need to be explained and supported in more detail.

Basis for Comment:

Assumptions that underlie the engineering analyses that are the basis for the evaluation of alternatives seem to predetermine the outcome of the Terrebonne report. Specifically, there is not enough information to explain or support these assumptions about the storm surge, wave, and wind sheltering effects of the barrier islands on the leeward estuary and wetland habitat.

Stabilizing the Terrebonne barrier islands has obvious benefits above and beyond protecting areas bayside of the Terrebonne islands; however, analyses are not provided showing the degree to which waves or surges will be reduced nor are storm surge reduction, wind and wave energy dissipation, and other possible benefits of barrier island stabilization discussed in detail. The Panel acknowledges that the larger the dimensions of the barrier island, the greater the benefits that would accrue for wetland and ecological protection in Terrebonne Bay. However, there is no justification to support why this is so, and the report does not distinguish between the benefits of building the island higher in elevation vs. enlarging the planimetric area of the island.

Additional specific comments about the proposed alternatives include the following.

- Appendix L, pp. 3-3 and 6-9, design of the 5-, 10-, and 25-year protection schemes (Plans C, D, E) utilized long-term erosion rates for the beach from Williams et al. (1992) and for the marsh from the U.S. Geological Survey (USGS). The erosion rates for the beach from USGS are smaller and were not used; however, the assumptions behind the selection of erosion rates are not provided.
- There is a discrepancy in the islands' acreage values over the last 30 years between Section 2.5 and Appendix L3.3. The former states that Whiskey Island decreased to 564 acres in 1988 (line #1195), while Figure L3.3 shows a total land area of 830 acres in 1988, per USGS. This discrepancy should be explained. Likewise, Table L3-3 (from USGS) suggests that the Whiskey Island beach area is gaining by 4 acres per year; however, the text following the table states that the beach habitat will disappear by 2029. It is likely that Whiskey Island is being eroded or relocated. The assumptions regarding erosion rates are not clearly stated.

Significance – Medium:

Clarifying the assumptions used in the engineering studies will help the reader understand and recognize the innate benefits of preserving and enhancing the barrier islands.

Recommendation(s) for Resolution:
To resolve these concerns, the report would need to be expanded to include: 1. Analyses and detailed discussion that demonstrate the degree to which the restoration project will provide environmental benefits from protection of the barrier islands and Terrebonne Bay estuarine and wetland habitats. 2. Discussion of the reason for using the using long-shore erosion rates from Williams (1992) rather than the lower rates provided by the USGS. 3. Reconciliation of the island acreage values between Section 2.5 and Appendix L3.3, or an explanation of the differences. 4. A comparison of the benefits of building the island higher in elevation rather than enlarging the planimetric area of the island. 5. Clarification of assumptions regarding erosion rates. 6. A graphic illustrating the changes in shoreline early in the report, possibly using diagrams in McBride et al. (1992), or a similar source.

Literature cited:

McBride, R.A., S. Penland, M.W. Hiland, S.J. Williams, K.A. Westphal, B.E. Jaffe, and A.H. Sallenger, Jr. (eds) (1992). Analysis of barrier shoreline change in Louisiana from 1853 to 1989. In: Atlas of Shoreline Changes in Louisiana from 1853 to 1989: U.S. Geological Survey Miscellaneous Investigation Series I-2150-A. Chapter 4.

Comment 8:

The role of barrier islands in enhancing and protecting mainland socioeconomic and business benefits is understated.

Basis for Comment:

The Louisiana Coastal Area (LCA) ecosystem (composed of the Gulf of Mexico, Louisiana mainland coast, and barrier islands) is a complex interconnected ecological, economic, and social system. The Terrebonne report generally understates these connections and the roles barrier islands have in enhancing and protecting mainland socioeconomic and business benefits by inaccurately asserting that the project will not affect socioeconomic and business factors (e.g., environmental and social justice, employment, income, cultural, historical and recreational resources) because the barrier islands are "remote and uninhabited" (i.e., since there are no people living on the islands, it is inaccurately asserted that there are no socioeconomic and business impacts to consider).

It is true that the LCA barrier islands of concern are "remote and uninhabitated," and thus that the project will not have socioeconomic and business impacts on the barrier islands themselves. However, as the barrier islands erode, coastal Louisiana wetlands are subject to greater exposure to erosive forces (e.g., wind, waves, storms), resulting in greater loss of coastal wetlands. This loss of coastal wetlands can have significant socioeconomic and business impacts on the mainland. For example, coastal wetlands serve as nursery grounds for commercial fish species. As coastal wetlands degrade, this nursery function can also degrade, leading to a decrease in commercial fish species and subsequent decreases in commercial fishing and in jobs and income on the Louisiana mainland that are related to the commercial fishing industry. Coastal wetlands also support recreational fishing by providing nursery grounds for recreational fish species and access points for Gulf of Mexico recreational fishing (e.g., boat ramps). As coastal wetlands degrade, recreational fish species and access points will also be degraded, leading to decreases in jobs and income on the mainland related to the recreational fishing industry. Decreases in jobs and income on the mainland tied to the negative impacts of coastal wetlands loss on the commercial and recreational fishing industries may fall disproportionately on low-income and/or minority human populations, raising environmental and social justice concerns. Coastal Louisiana wetlands are also home to unique human cultures with a rich history which are closely tied to fish and wildlife species (e.g., through fishing and hunting). These unique cultures and associated historical resources are also threatened by reductions in fish and wildlife populations caused by coastal wetlands loss. They are also the first populations to be impacted by flood damages from hurricanes and storm surges, the effects of which are reduced by effectively functioning barrier islands.

If the socioeconomic benefits afforded by the Terrebonne Basin barrier islands are not described or quantified in sufficient detail, readers will not completely understand how barrier island loss may increase coastal Louisiana wetlands loss, which in turn will adversely impact mainland businesses (e.g., jobs, income) and socioeconomic resources

and concerns (e.g., cultural, historical, and recreational resources; environmental and social justice concerns).
Significance – Medium:
A description of the economic and cultural importance of ecological resources for the region is key to demonstrating that socioeconomic benefits of barrier island restoration that go beyond the barrier islands themselves, providing greater justification for the proposed project(s).
Recommendation(s) for Resolution:
To resolve these concerns, the report would need to be expanded to include: 1. More discussion of the ecological, economic, and social connections between the LCA barrier islands and mainland, and, in considering these connections. 2. Discussion of how barrier island erosion may impact socioeconomic and business "triple-bottom line" (e.g., environment, economic, equity) concerns on the mainland.

Comment 9:

The Terrebonne report should explain that, although the objectives of the Terrebonne project will be met by the Tentatively Selected Plan (TSP) on a local scale, the project will not fully meet the LCA objective of restoring the geomorphologic form and function of the Terrebonne Basin barrier islands.

Basis for Comment:

The main objective of the LCA Restoration Project is to restore, at the regional level, the geomorphologic form and function of the Terrebonne Basin barrier islands for the protection of interior coastal resources from the direct effects of wind, waves, and storms. The proposed TSP will meet the objective of restoring habitats only in the vicinity of the limited area to be restored (Whiskey Island).

Restoring and improving a single barrier island will not fully provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, as originally proposed. Nonetheless, the TSP will provide high-quality habitat at smaller scale. Also, by restoring one barrier island, sediment input to supplement longshore sediment transport processes along the Louisiana shoreline will be drastically reduced relative to the sediment input that would have been provided if all the Terrebonne Basin barrier islands were restored

The restoration of a single island in the barrier island chain will not stop the current degradation trend, and the ability of the Terrebonne Basin barrier islands to provide functions that benefit leeward wetland habitat on the mainland will not be greatly improved. Therefore, the LCA objectives will not be met at the regional level, but the TSP will contribute to the enhancement of a degraded barrier island, ultimately providing higher habitat quality for migratory birds, flora, and fauna associated with barrier islands.

Significance – Medium:

By not clearly explaining that the TSP will only be able to provide ecological benefits locally, the reader may not understand that the objectives of the LCA Restoration Project will not be fully met and that the Terrebonne Basin barrier island system will continue to degrade.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. More detailed justification and explanation for restoring one single barrier island.
2. Greater detail on the benefits that coastal Louisiana will obtain from restoring Whiskey Island only.
3. A strong monitoring plan to determine the success of restoring Whiskey Island and its benefits to the Louisiana shoreline.

Comment 10:

The justification for parameter selection and model calculations, as well as information on validation and application of the Wetland Value Assessment (WVA) models, should be provided.

Basis for Comment:

The discussion on p. 3-42 in the Terrebonne main report references the WVA models, but the report does not explain why the WVA model defines a combination of dune, beach (supratidal), and marsh (intertidal) as the optimum habitat metric by which the island ecosystem functions should be compared. A detailed description of the ecosystem functions to be restored and how these functions are connected to dune, beach, and marsh acres is not provided. The Habitat Suitability Index (HSI) model described on p. 3-75 in the Terrebonne main report is used to capture both the quantity (e.g., acres) and quality of habitat. However, the report does not explain how the HSI incorporates quality.

Although the variables included in the WVA models are recognized scientifically and technically as important for characterizing overall habitat quality, they are not the only variables that could have been selected. There is no justification or rationale in the Terrebonne report for model parameterization (i.e., why the variables selected for the WVA models were included). There also is no explanation or justification for the assignment of Suitability Index (SI) values to each of the model variables or how the variables were weighted in the HSI models.

Furthermore, no information of the validation of the models is provided, and their performance is uncertain. This information is important for the reader to understand the scientific basis of the models, how the model outputs reflect habitat quality, and how accurate the model outputs may be.

Significance – Medium:

Without information on WVA model parameterization, calculations, validation, and application, confidence in the ability of the model outputs to accurately reflect habitat quality may be undermined because their scientific basis and performance is poorly understood.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. A better explanation of how the model is parameterized.
2. Explanation and justification for the assignment of SI values to the model variables.
3. A description of how the model has been validated and used in other restoration projects.
4. Information on the data that were used for input to the WVA model.
5. More complete explanation of why the WVA model outputs are an optimum habitat metric for measuring and comparing the ecosystem functions and services restored by different project(s).

Comment 11:

The construction design and expected performance of the TSP should be described in greater detail.

Basis for Comment:

The Terrebonne report provides only a limited amount of information on the construction design and expected performance of the TSP. The construction phase requires a better description because, at this point, there is no contract in place to implement the TSP.

- The assumed beach and dune elevations (2.2 ft and 4.4 ft above mean high water [MHW]) seem low, and there is no explanation for how these elevations are consistent with existing ones. Changes to the proposed beach/dune geometries are not evaluated to determine if there is a potentially more efficient layout for the construction of the TSP that will result in greater benefits (i.e., further reduction in the rate of deterioration of the Terrebonne barrier islands and greater storm surge protection for leeward wetland habitats) and lower short-term impacts to existing habitats.
- Section 3.9.1.2 (p. 3-99) should clarify that the itemized construction schedule of 560 days is for the TSP and does include a contingency. The itemized schedule calling for 348 days of dredging would require a potentially unrealistic dredge production volume of 25,574 cubic yards per day. However, when the contingency is added to the schedule, the projected dredge-production requirement is more realistic.
- Regarding Appendix L, p. 9-8, Section L9.3.1, it is not clear whether the dredging quantities (in the cost estimates) included the 1.13:1 and 1.6:1 dredge-to-fill ratios. The physical basis of the volume quantities described in the report, including those used for cost estimating, should be explained more precisely. For example, regarding the sediment quantities considered to be the in-place pay-template measure, it is not clear if they include handling losses. Also, it is not clear if the sediment quantities include overfill allowance for long-term losses during fill equilibration associated with compatibility.
- More explanation is required for the statement on p. 3-79 that, "The original contingency was also refined using Crystal Ball." It is not clear if separate analyses were done using Micro-Computer Aided Cost Estimating System (MCACES) and with Crystal Ball or if the refinement of the contingency was done jointly with both programs.
- It appears that a 25-year duration of effectiveness is assumed, as the operations and maintenance (O&M) plan described will still allow the islands to continue to degrade. The Panel assumes that information and data about the rate of erosion are available, allowing estimates for the approximate time it would take for the existing islands to completely disappear under the No Action Alternative. However, this information is not presented in the report, and it is important for providing a reference point to compare the projected outcome of the TSP with the No Action Alternative.

- The benefits of the proposed barrier island restoration are a function of the marine forcing functions that occur during the suggested 25-year period. If it is expected that a series of small tropical storms will occur where wind waves dominate, then measurable benefits are more likely. If there are one or two larger hurricane storm surge events during the 25-year period, then it is less likely that there will be measurable benefits, and further degradation of the islands could occur. However, anticipated hurricane, tropical storm, and wind wave time-series conditions are not presented or discussed. The storm surge protection afforded by the TSP and the way in which it is expected to change over the 25-year life of the project are also not reported. Furthermore, the explanation of the "qualitative benefits" of the TSP mentioned on p. 3-80, line 3472, and the description of the components of the fully funded cost estimate ($120 million) provided on p. 3-81, line 3503, do not emphasize the downside of a No Action Alternative. Providing this information could further strengthen the presentation of the TSP.

Significance – Medium:

A complete description of the construction design and expected project performance is necessary to understand how the TSP should be implemented.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include the following:

1. A detailed description of how the TSP should be constructed to obtain the greatest performance and minimize short-term impacts from the restoration.
2. Clarification of development of cost contingency factors discussed on pp. 3-79 and 3-80, especially how the various computer programs relate to each other.
3. Additional discussion of the effects of erosion and storm events on the order of a 25-year to 50-year return period. A qualitative assessment of the effects of larger events such as the 25-year to 50-year magnitude would be helpful. No new analysis or modeling is being recommended but should be provided if it was performed.
4. A comparison of the results of a No Action Alternative with the TSP to demonstrate the effectiveness of the TSP. For example, to emphasize the downside of a No Action Alternative, a more detailed explanation of the "qualitative benefits" of the TSP (p. 3-80, line 3472) should be provided, along with a brief description of the components of the fully funded cost estimate ($120 million) (p. 3-81, line 3503) should be provided.
5. The protection abilities of the TSP, the NER plan, and other alternatives from expected wind wave and storm conditions.

Comment 12:

The description of the scope and cost-sharing for the Adaptive Management and Monitoring Plan requires additional detail, and the projected costs for its administration may be underestimated.

Basis for Comment:

The monitoring plan is a significant element of the project because of the valuable information that it can provide to the planning and implementation of larger-scale (NER) projects. The monitoring plan is not sufficiently detailed to inform follow-on project(s) or to specifically address the uncertainties associated with formulation of the current (TSP) project. The project provides an excellent learning opportunity that may be among the project's most valuable contributions/achievements, provided that the monitoring plan is comprehensive and appropriately designed, detailed, and executed. Based on the following observations, the cost of monitoring, and its allocation within the project budget, is insufficiently evaluated and described.

- The performance measures, desired outcome, and monitoring design were only generally described and did not provide sufficient detail to fully understand what will be done. For instance, the Terrebonne report implies that all of the islands in the Terrebonne Basin Barrier Shoreline restoration area will be monitored, but it is not explicitly specified which island(s) will be monitored, which environmental parameters will be monitored, or the frequency with which environmental data will be collected and reported. Furthermore, it is not clear who will conduct the monitoring program or evaluate the results of the monitoring program.
- No procedures are described to estimate or measure the structure and function of the barrier island. For instance, the monitoring plan does not indicate how the success of the plant community will be evaluated, how nesting success of migrating birds will be evaluated, or whether vegetation maintenance will be required. This information is important to consider when measuring the success of the restoration project.
- The methods for assessing the geomorphologic response of the barrier islands to local sea level rise (RSLR) upon the project area islands are not described in the monitoring plan. Specifically, the monitoring plan does not describe objectives relative to understanding, assessing and/or quantifying physical processes associated with island migration (rollover), deflation, longshore sediment transport/exchange between islands, the effects of tidal flows along/between islands, and the rate of RSLR at the islands vs. the nearby mainland.
- The costs of executing and/or administering the monitoring program may not be sufficient to allow for a meaningful, comprehensive evaluation of the islands' physical processes and project performance, and to allow for unexpected anthropogenic and natural disasters.
- The overall cost-sharing of monitoring is unclear. It is stated that this cost will start with a Preliminary Engineering Design (PED) phase and be listed in the construction budget. However, it does not appear that the $5 million+ cost of

monitoring is included in the overall project cost, in the budget sheets in Annex L-6, or in Section 3.9.2 of the Terrebonne main report.

- On p. 17 of Appendix I, the $5,821,200 value for adaptive management and monitoring is not justified because it is not supported by the addition of Tables 1, 2, and 3. It is not clear whether Tables 1 through 3 in Appendix I are intended to be additive. If so, they sum to $5,073,600, which is less than $5,821,200. Regardless, an allowance of approximately $5.1 million to $5.8 million may be unrealistic to administer a meaningful monitoring and assessment program that spans 10 years along such a broad study area, particularly if the program is successfully designed and detailed to inform the critical and much more costly follow-on NER project(s).
- The cost-sharing of the Adaptive Management and Monitoring Plan (Appendix I) is not clear in Section 3.9.3. This cost may be largely after construction. It is estimated as $340,000 (or more?) per year, but Section 3.9.3 does not clarify how or when these funds are to be expended, and which party is responsible for the cost.

Significance – Medium:

Whether the long-term benefit and success of the project will be well represented or well understood cannot be determined without the formulation of a more detailed Adaptive Management and Monitoring Plan that is adequately described and funded.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. A more detailed description of the physical (spatial) scope, frequency, and execution of the monitoring plan, including an outline of the agency(ies) that will perform the monitoring and interpret the results, as well as the frequency and scope of presentation of the results.
2. Expansion of the monitoring plan to better assess the physical processes that govern the geomorphologic changes of the islands, including sediment transport processes and the volume of sand that is transported away from the placement sites, and especially the effect of local, RSLR at the island complex (relative to that of the nearby mainland/marsh areas).
3. Further consideration of the short-term and long-term (10-year) costs of implementing and administering a comprehensive monitoring program.
4. Clarification of the costs associated with the Adaptive Management and Monitoring Plan, and the timing and cost-sharing responsibilities of those costs during and/or after the PED and construction stages of the project.

Comment 13:

The Abstract and Executive Summary (ES) should be expanded to include more specific descriptions of the TSP and NER plan, and the Terrebonne main report should include graphic illustrations of these plans.

Basis for Comment:

The ES, and especially the Abstract, do not clearly describe the elements of the TSP and NER plan.

- The Abstract (p. A-2, ES lines #67-69) never describes what the TSP consists of. (This description appears later, in ES lines #271-3). Beyond the cost (ES line #89), the Abstract does not summarize the principal TSP elements (i.e., physical scope, cubic yards of fill, fencing/vegetation, anticipated sand sources, schedule, acreage output, and anticipated performance, including construction impacts and net habitat over time).
- The Abstract describes the scope of the NER plan (ES lines #45-58); however, the ES (line #354) does not describe which alternative is the NER plan (i.e., Alternative #5). The cost of the NER plan is not described, nor is the physical size of the project in terms of cubic yards of fill, etc., or the use of offshore sand sources.
- The Abstract refers to "Plan C" and "Plan E", but does not describe the physical meaning of these alphabetically labeled plan alternatives (i.e., allowance for X years of background erosion/land loss).
- Neither the Abstract, the ES, nor the Terrebonne main report clearly indicate the amount of existing acreage of intertidal, beach/dune, and marsh habitat that will be directly impacted by construction (burial).
- Graphic illustrations of the elements of the proposed TSP and NER plan that are central to understanding the physical scope of the project (e.g., planform and/or section views) are not included in the Terrebonne main report (i.e., Sections 3.6 and 3.7). Although plan drawings are included in Appendix L, Annex L-2, these are cumbersome for a typical reviewer to access in the report, and the Annex L-2 drawings do not identify which plates correspond to the TSP and NER plan. Furthermore, Section 3.7 (pp. 3-79 to 3-80) does not delineate what elements make up Alternatives 11 and 12, nor does it describe the physical size of at least the TSP (cubic yards of fill, fence, etc.).
- The ES does not explicitly state that the fundamental metric for evaluating (screening and selecting among) the plans was the net increase in functional island area relative to construction cost. This simple statement is central to understanding the formulation and selection of the plan.

It is important to realize that most readers will try to gain this information from the Abstract and ES.

Significance – Medium:
Without a clear description of the scope and elements of both the TSP and NER plan in the Abstract, ES, and main report, it is not possible to easily comprehend and assess the scope and benefits of the proposed project(s).
Recommendation(s) for Resolution:
To resolve these concerns, the report would need to be expanded to include: 1. A more comprehensive description of the TSP and NER plan in the Abstract and the ES. 2. Graphic illustrations of the TSP and NER plan within the Terrebonne main report (i.e., copied from the appropriate plates in Annex L-2). 3. A brief description of the amount and type of existing acreage that will be directly impacted by construction of the TSP and NER plan. 4. A brief summary of the manner in which project benefits and costs (net output) were used toward selection of the TSP and NER plan, vs. the overall goal of restoring the island chain/system to protect the estuary and wetlands to the north.

Comment 14:

The approach used to calculate habitat acres created at Year 1 and subsequent years should be explained in more detail, including whether the number of acres calculated includes existing habitat.

Basis for Comment:

It is not clear how the acres of habitat restored were calculated. Calculation of the habitat acre estimates is found in Appendix L, p. 6-14, and also in Appendix K. Page 4-5 of Appendix K states that the TSP (Whiskey Plan C) involves 422 cubic yards/ft sand placement along 19,763 ft of shoreline for dune/beach creation. For a beach elevation of about +4 ft and closure depth of -10 ft (which is also close to the existing depth at toe of fill), a fill density of 422 cubic yards/ft should yield about 27/14 x 422 = 813 ft of net shoreline advance, according to the Bruun Rule. Along 19,763 ft of shoreline, this equates to 370 acres. Alternately, the Island Plans in Annex L2 for Whiskey Plan C show about 1,100 ft of initial fill width from landward-edge to the MHW line (elevation = 1.6 ft). Along 19,763 ft of shoreline, this equates to 500 acres of initial beach/dune construction above the waterline. So, in sum, the beach/dune fill, at about Year 1, should create at least 370 acres to as much as 500 acres of beach/dune. But Table 3-11, Table K4-2, and Table L6-7 indicate that the plan will create 895 acres of beach/dune at Year 1, or 1.8 times more acres than is suggested by the initial construction plan, or 2.4 times more acres than is suggested by a standard equilibration model. This may be because the tables include the existing conditions, but it is unclear. This discrepancy should be explained.

Likewise, the Whiskey Plan C drawings (Annex L3) indicate marsh construction of about 900-ft width along 4500 ft of shorefront. This equates to 93 acres of intertidal marsh creation. In contrast, Tables 3-11, K4-2, and L6-7 indicate that 377 acres of marsh are created at Year 1. Again, this may be a function of the inclusion of existing conditions, but it is unclear.

Significance – Low:

There appear to be discrepancies in the acres of dune, beach, and marsh created by the various alternatives because the method by which the acreage calculation is made, or described, is not clear.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. An explanation of how acres of habitat created are estimated for Year 1 and subsequent years.

Comment 15:

Information from the risk and uncertainty (R&U) analysis in Appendix L-5 should be brought forward into the main body of the Terrebonne report.

Basis for Comment:

R&U is handled well in the analysis in Appendix L-5, but it is only briefly described in the Terrebonne main report. Section 3.8 does not summarize the R&U method or results (e.g., the adoption of 80% confidence levels, etc.). Similarly, Section 3.8 does not list the summary outcome of the analysis (such as is shown in Table 7 from Appendix L-5), nor does it specify that the costs include a 28% contingency that resulted from the R&U analysis in Appendix L-5 which reflects the 80% confidence level.

Significance – Low:

The readability of the Terrebonne report would be improved by bringing forward more information from the R&U analysis in Appendix L-5 into the main body of the report.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. A brief summary of the method used to evaluate R&U in Section 3.8 of the Terrebonne report.
2. Inclusion of Table 7 from Appendix L-5 in Section 3.8 of the Terrebonne report and/or a description that explains how the 28% cost contingency reflects the 80% confidence level developed through the R&U analysis.

Comment 16:

Minor editorial and technical revisions to the Terrebonne report should be made to improve the quality of the report.

Basis for Comment:

The Panel identified some issues that should be addressed in order to improve the quality of the Terrebonne report, including:

- Line 2100 refers to greater description of details in Section 3.3.2.2, but that section is not found. Does Line 2100 mean to refer to Section 3.2.3.3?
- On the CE/ICA figures in Section 3, the units on the "output" (horizontal axis) should be shown (e.g., HAs or HUs).
- It is not clear why $cost/AAHU in Table 3-30 is different from Table K2-1 in Appendix K.
- Sections 3.3.1 and 3.3.2 are missing from the report and Table of Contents.

Significance – Low:

The presence of technical errors and the absence of report sections reduces the quality and professional appearance of the Terrebonne report but will not affect the technical quality or comprehension of the information presented.

Recommendation(s) for Resolution:

To resolve these concerns, the report would need to be expanded to include:

1. A more detailed explanation for the items identified in the Basis for Comment.
2. A thorough technical review of the draft Terrebonne report to address all technical issues.

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